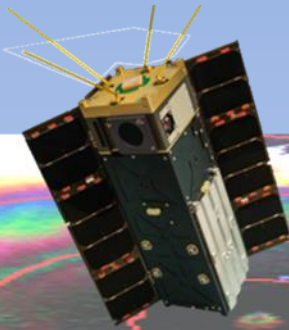


Working with Yoram

...from Ideas to Reality.



J. Vanderlei Martins – UMBC
Department of Physics and
JCET/NASA GSFC Climate &
Radiation Laboratory



Acknowledgements

- PhD Students
 - Reed Espinosa
 - Daniel Orozco
 - Brent McBride
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 - Adriana Rocha Lima (currently at Goddard)
 - Gergely Dolgos (in Switzerland)
 - Li Zhu
- Lorraine Remer (JCET-UMBC)
- Roberto Fernandez-Borda (JCET-UMBC)
- Oleg Dubovik (Univeristy of Lille, and UMBC)

Three out of the many Projects I had the privilege to work with Yoram:

- Aerosol Absorption
- Cloud Side Measurements
- Design of new satellite missions

The ideas:

- **Aerosol Absorption**
 - Critical Reflectance: *Fraser and Kaufman 1985*
 - Aerosol absorption over sunglint: *Kaufman et al. 2002*
 - Spectral Reflectance measurements: *Martins et al. 2009*
- **Cloud Side Measurements**
- **Design of new satellite missions**

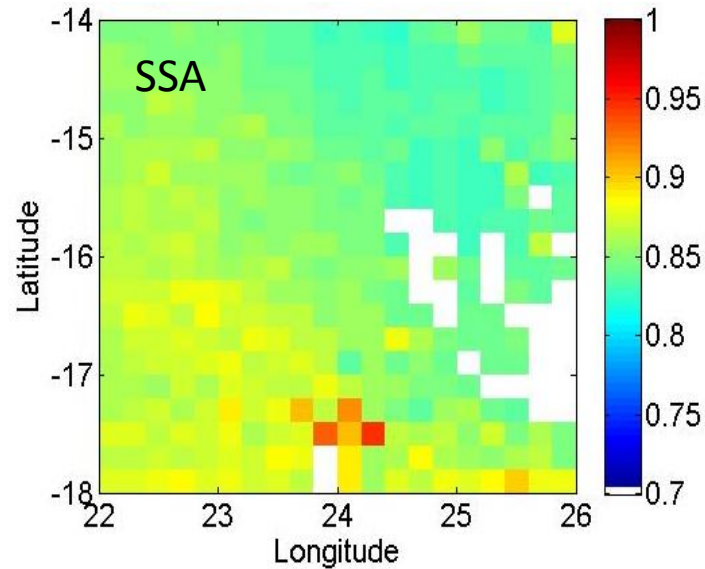
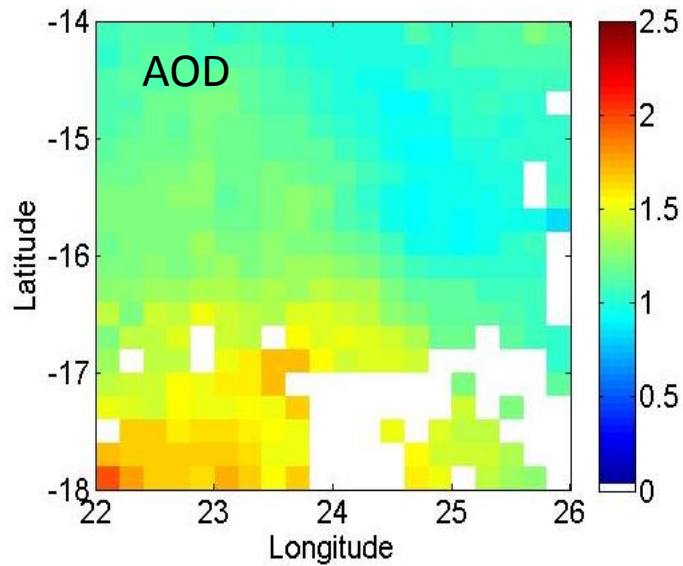
The ideas:

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 - Idea presented to Yoram and others in 2002
 - Yoram was the only scientist at the time who answered: “Lets do it. I will find the resources to cover it...”
- **Design of new satellite missions**

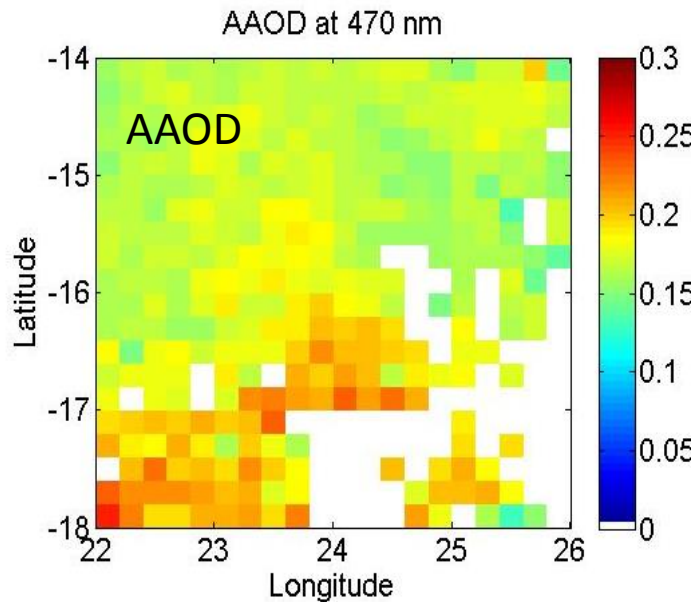
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- **Design of new satellite missions**
 - CO2BRA – measure BC from Space over sunglint:
 - AEROSAT – preview to ACE mission
 - CLAIM-3D – Cloud Side microphysical profiles

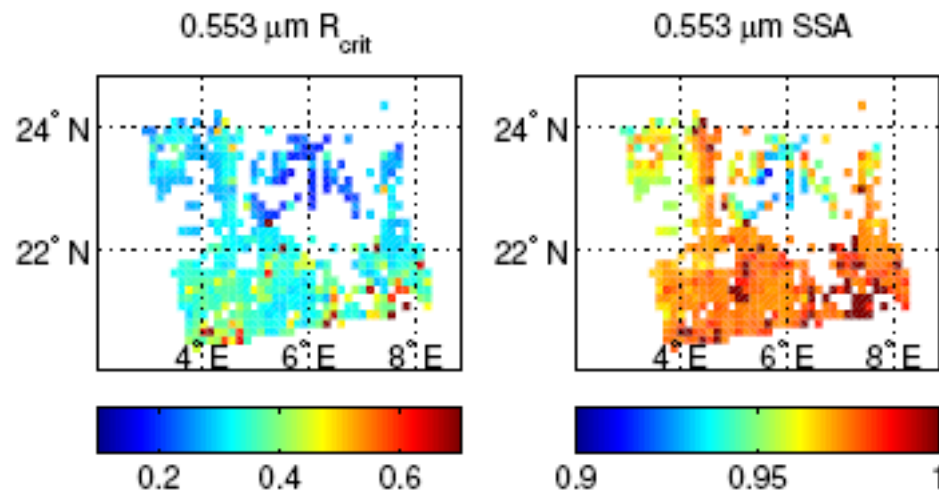
Critical Reflectance Maps of Aerosol Absorption



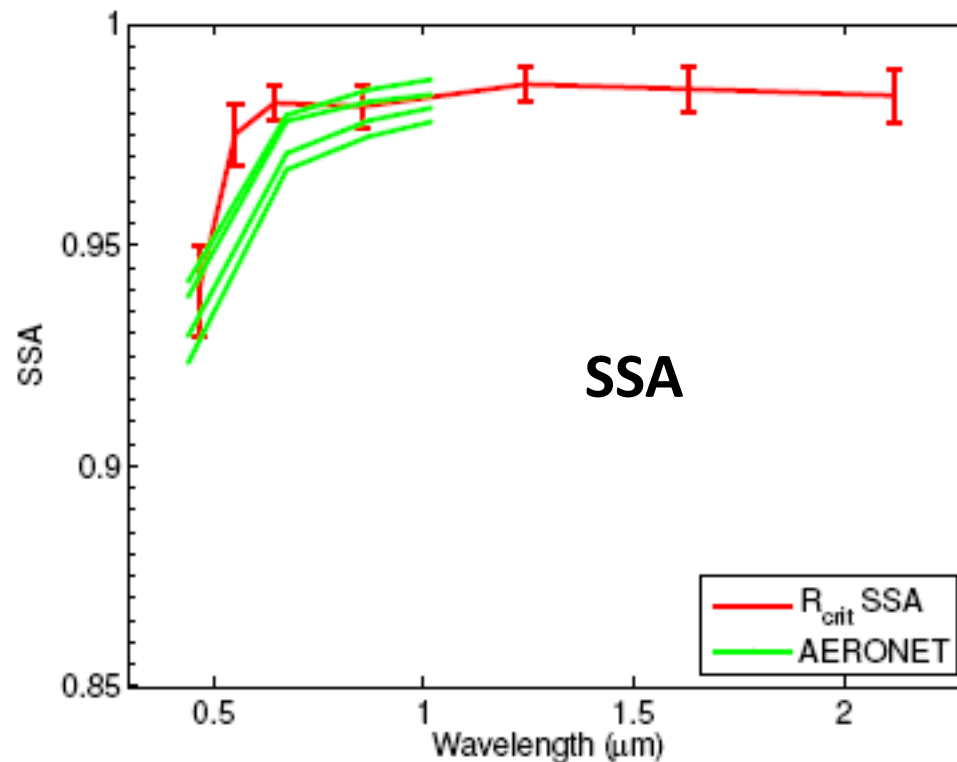
*Zhu, Martins
and Remer
2011*



AERONET sites	SSA (at 470 nm)		SSA (at 550 nm)		SSA (at 670 nm)	
	AERONET	MODIS	AERONET	MODIS	AERONET	MODIS
Alta Floresta	0.92 ± 0.02 (22 cases)	0.92 ± 0.03	0.91 ± 0.03 (22 cases)	0.92 ± 0.03	0.92 ± 0.03 (18 cases)	0.90 ± 0.03
Senanga	0.86 ± 0.01 (7 cases)	0.87 ± 0.01	0.85 ± 0.01 (7 cases)	0.87 ± 0.01	0.84 ± 0.01 (7 cases)	0.86 ± 0.01
Mongu	0.88 ± 0.02 (14 cases)	0.86 ± 0.02	0.87 ± 0.03 (14 cases)	0.86 ± 0.02	0.86 ± 0.03 (14 cases)	0.84 ± 0.02
Mwinilunga	0.90 ± 0.02 (3 cases)	0.86 ± 0.01	0.90 ± 0.02 (3 cases)	0.85 ± 0.01	0.89 ± 0.03 (3 cases)	0.84 ± 0.01



Dust Spectral
 ω_0 results with
 MODIS:

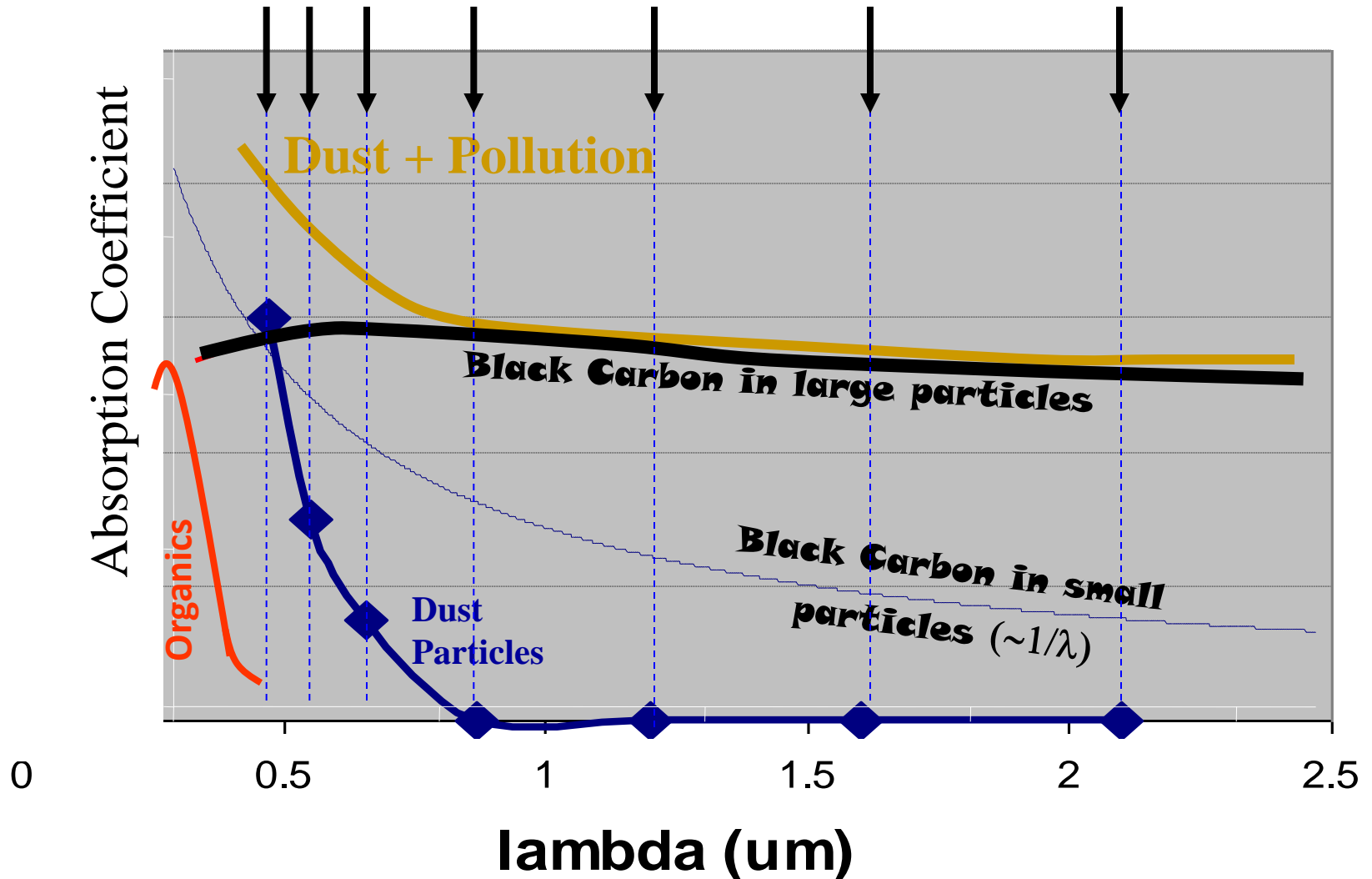


Wells, K. et al, 2012

Figure 7: 22 February 2007 0.553 μm R_{crit} (upper left), SSA (upper right), and spectral SSA at Tamanrasset (lower) from R_{crit} and AERONET.

Aerosol Spectral Absorption

MODIS Aerosol Bands:



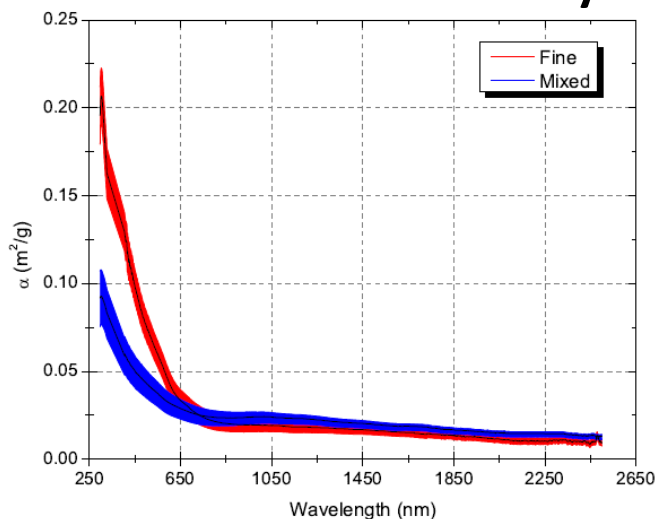
Aerosol Spectral Absorption Measurements – *Rocha-Lima et al.*

Volcanic Ash Eyjafjallajökull (Iceland)

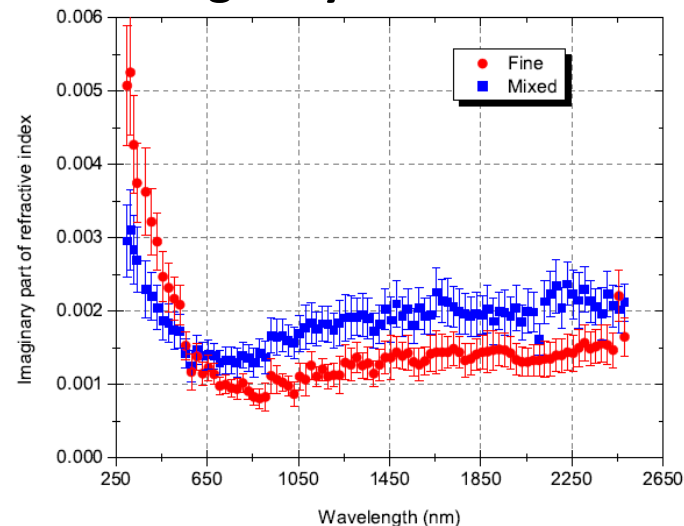
Ash was collected on the ground, about 35 km from the center of the eruption of the volcano.



Mass Abs. Efficiency



Imaginary Ref. Index

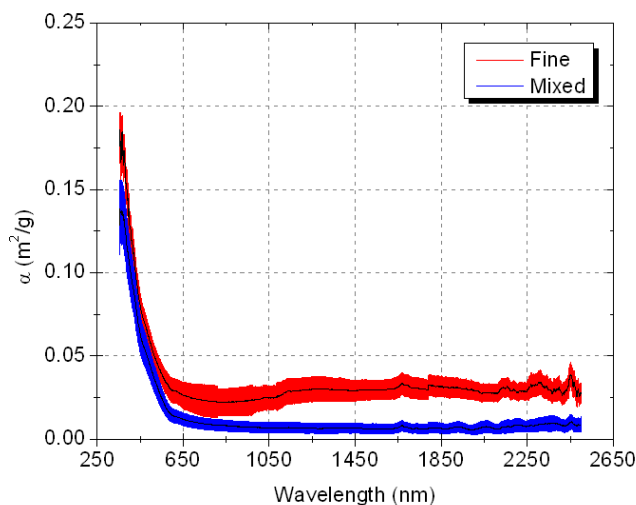


Saharan Dust

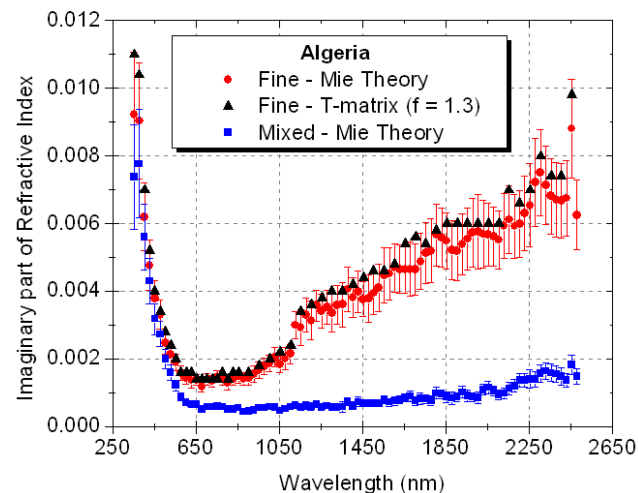
Sample collected on Bordj Badj Mokthar in Algeria (Supersite 1) during Fennec campaign in June 2011.



Mass Abs. Efficiency

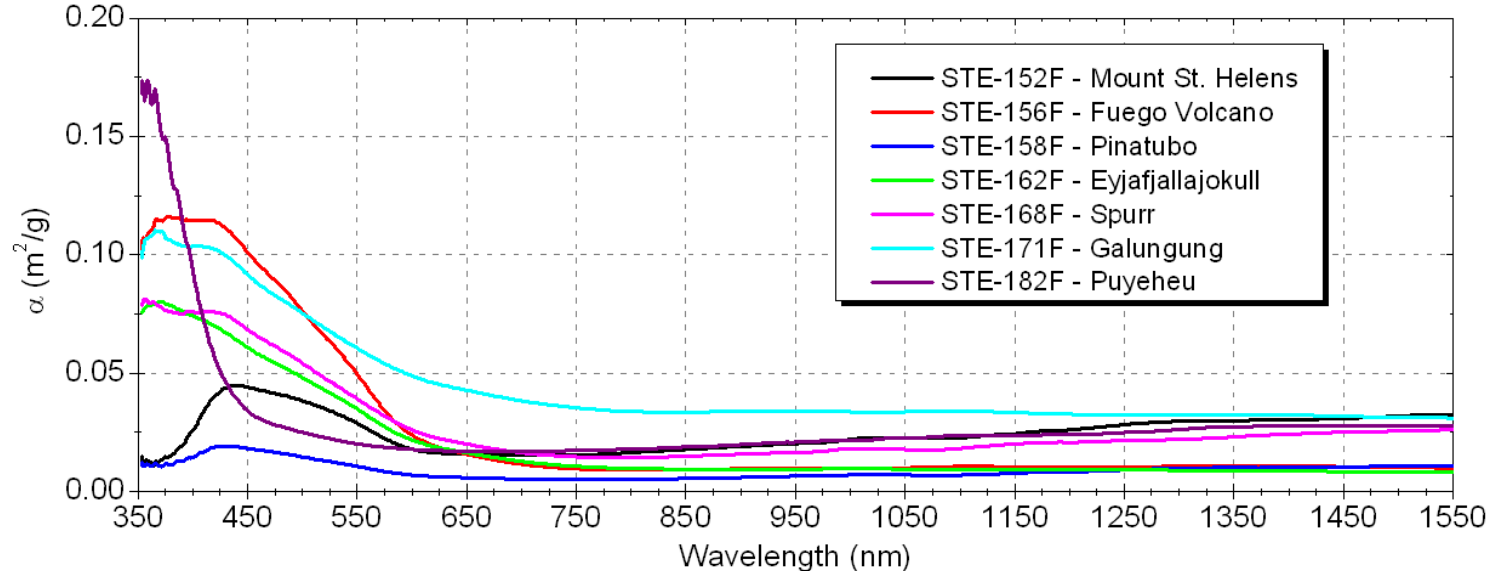
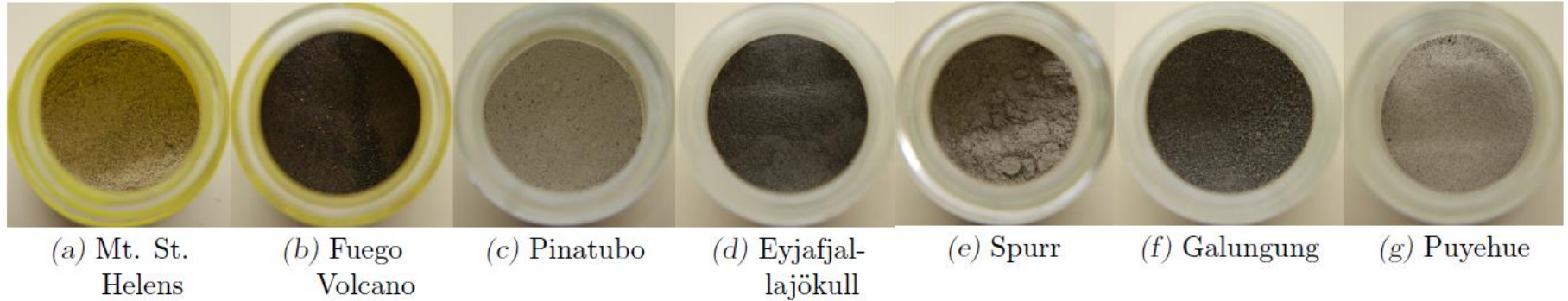


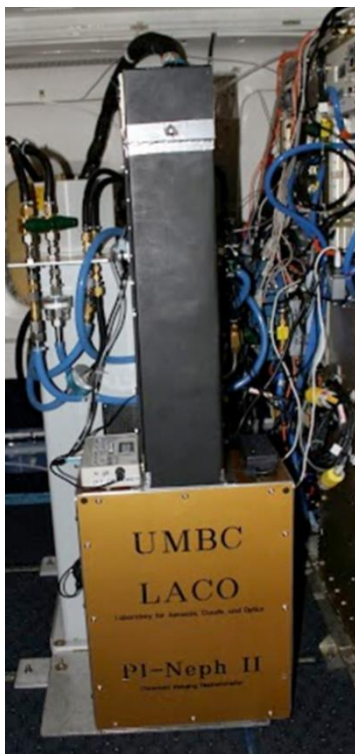
Imaginary Ref. Index



(Rocha-lima et al. in preparation)

Volcanic ashes:



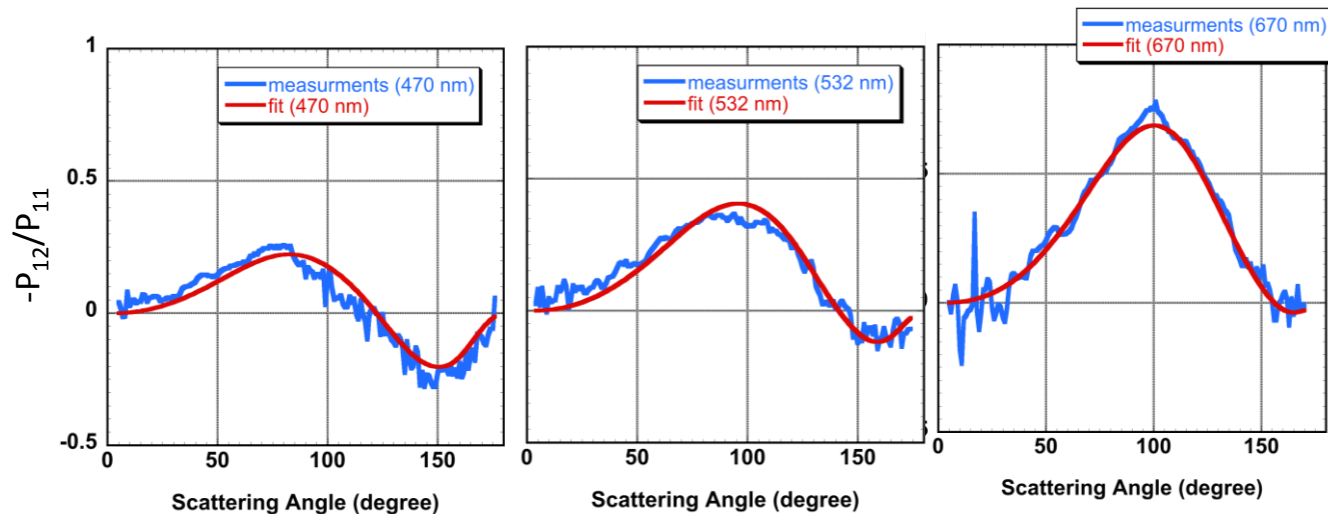
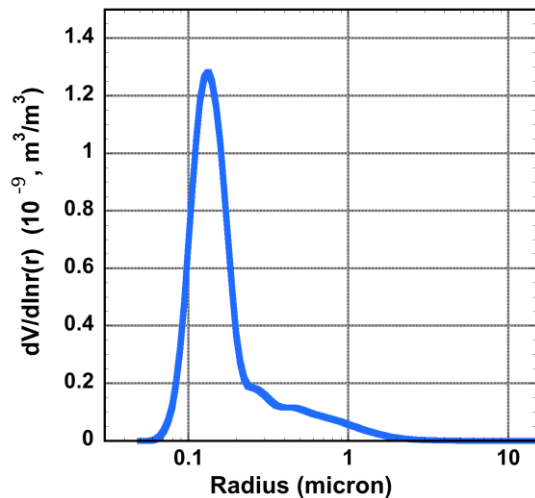
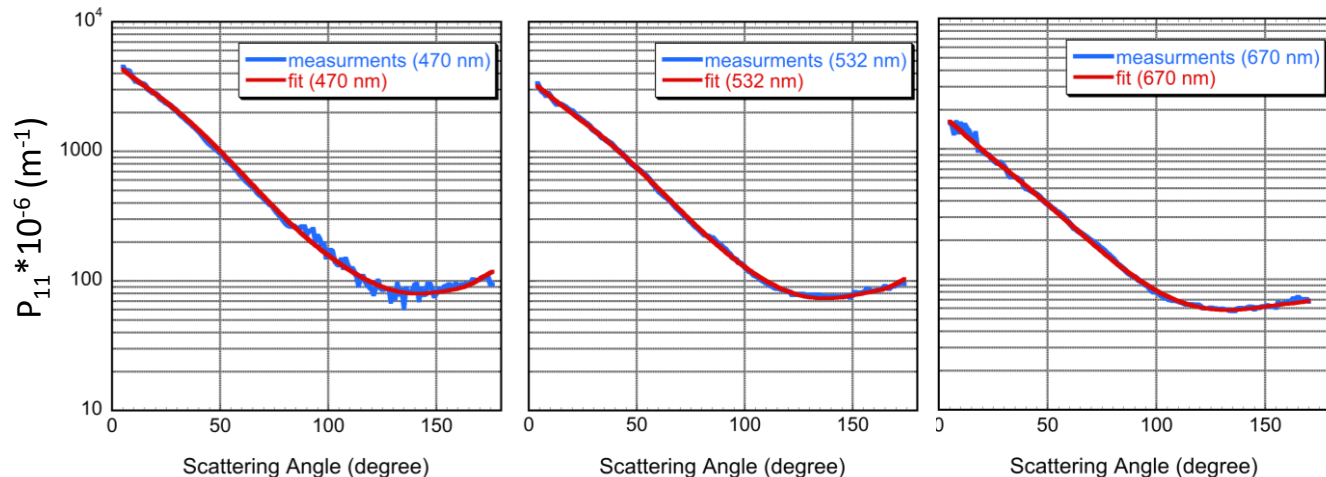


PI-Neph Retrievals from SEAC4RS

UMBC

W. Reed Espinosa, J. Vanderlei Martins, Oleg Dubovik, Lorraine Remer

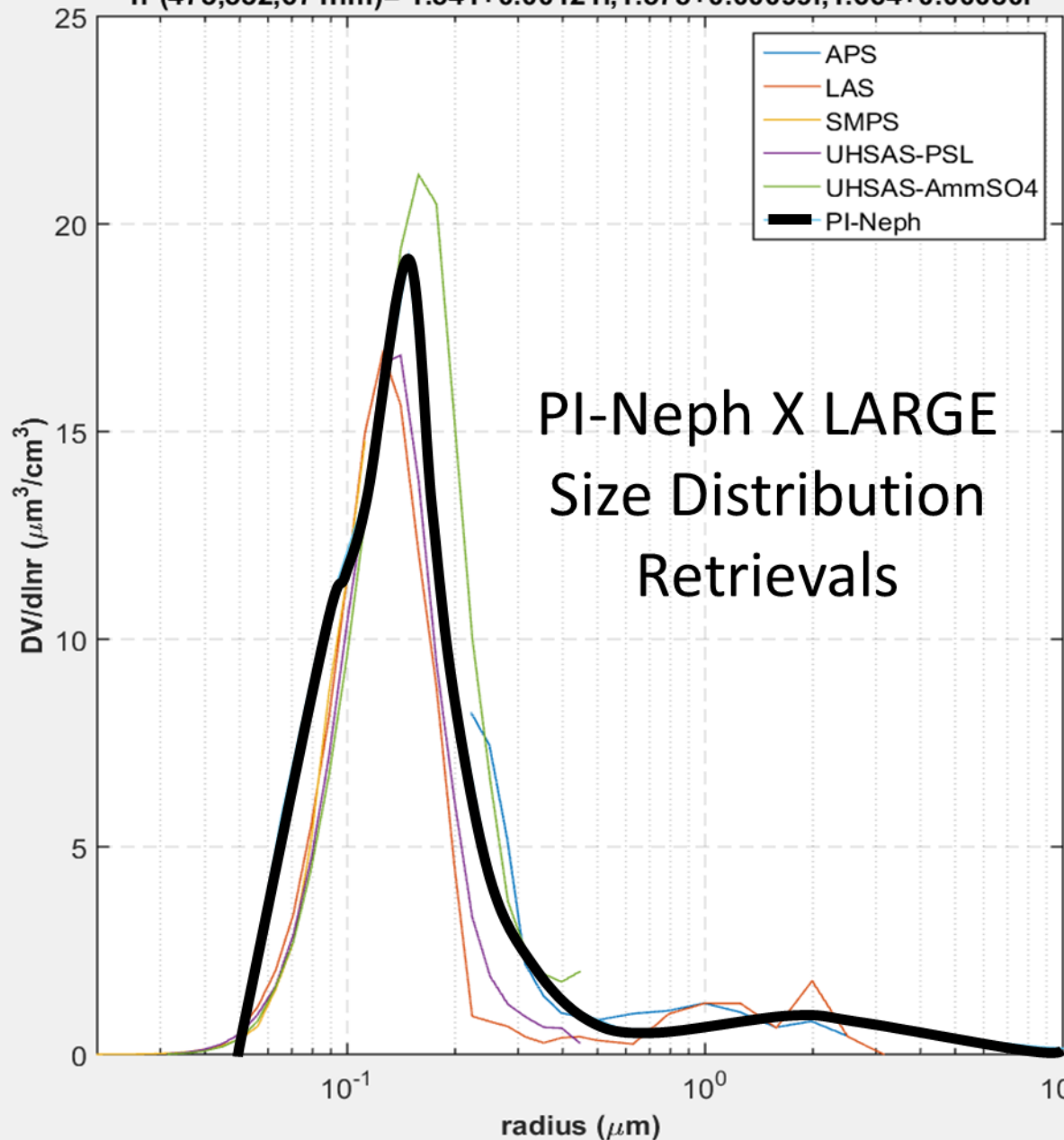
PI-Neph produces unique direct/airborne measurements of polarized phase function of aerosols, and the retrievals of size distribution and refractive indices using both P11 and $-P_{12}/P_{11}$ at 3 wavelengths.



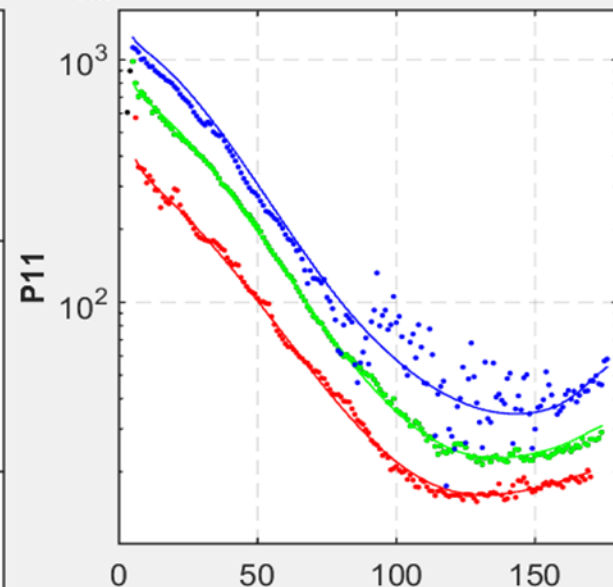
8/26/2013

Espinosa et al. (in preparation)

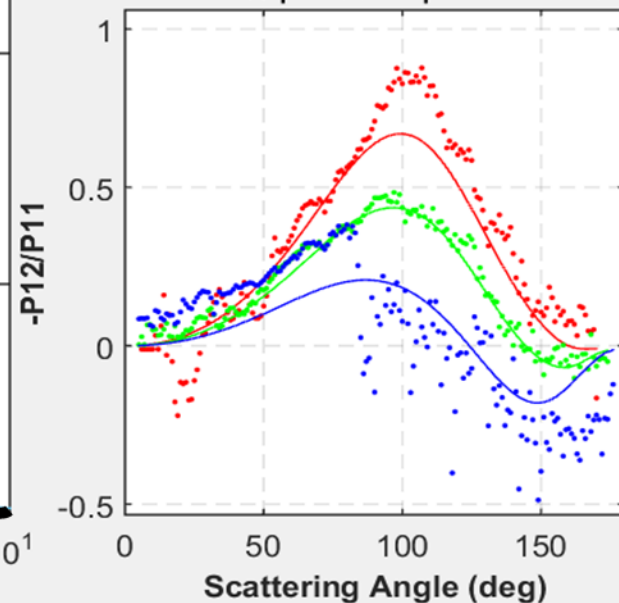
Aug 19, 2013 | Case-1, 18:24:17 to 18:36:31 UTC | sphere=76.3%
 $n^*(473,532,671\text{nm}) = 1.541+0.00121i, 1.575+0.00099i, 1.664+0.00080i$



$\sigma_{\text{PIN}}(473,532,671\text{nm}) = 173, 113, 65 \text{ Mm}^{-1}$
 $\sigma_{\text{TSI}}(450,550,700\text{nm}) = 184, 117, \text{NaN} \text{ Mm}^{-1}$



RH=12% | T=302K | P=61745Pa

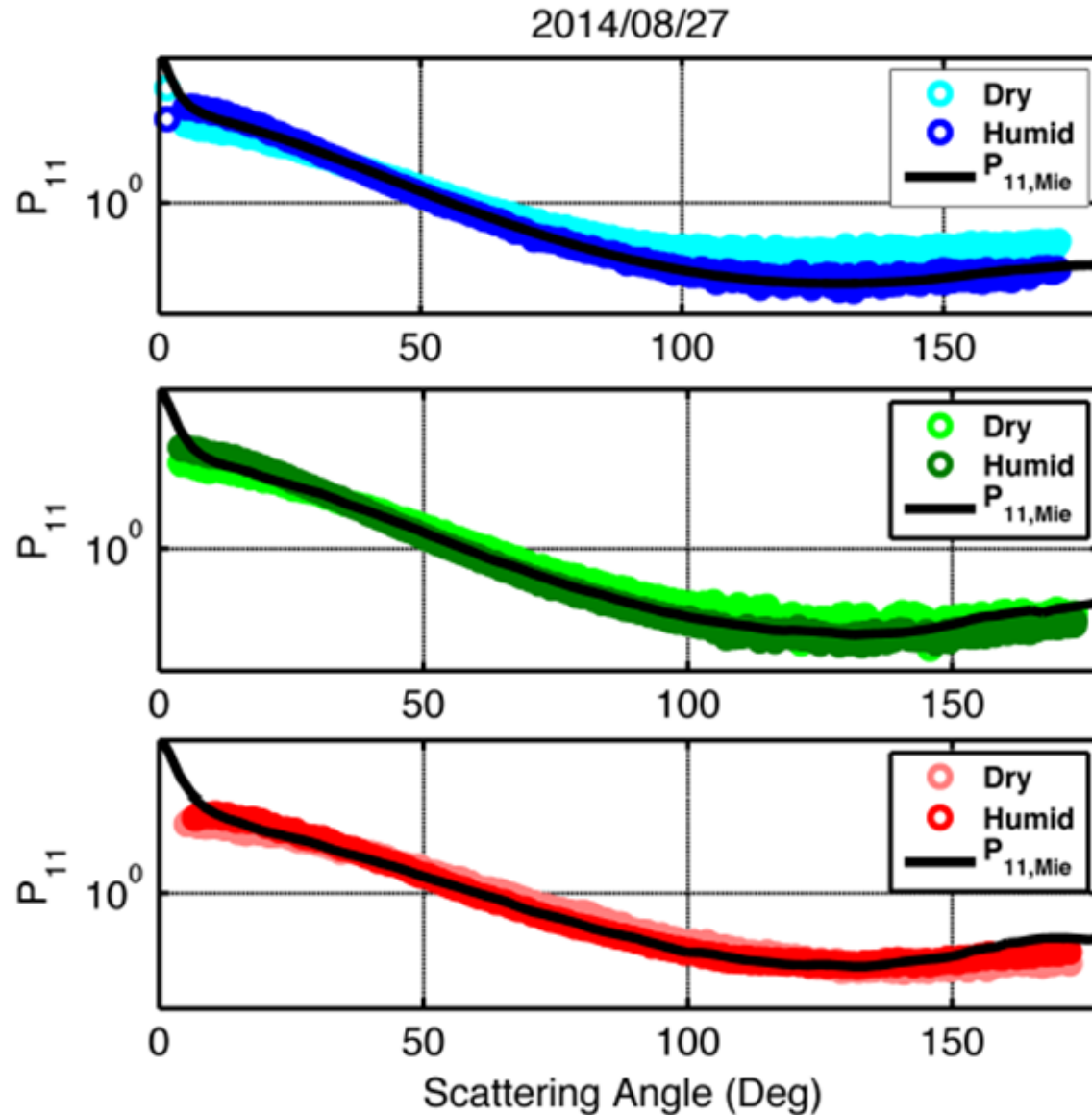


How the particle properties
depend on Ambient
conditions?

In Particular RH...

Dried/Humidified Ambient aerosols

PI-Neph X AERONET



Laboratory measurements of Aerosols

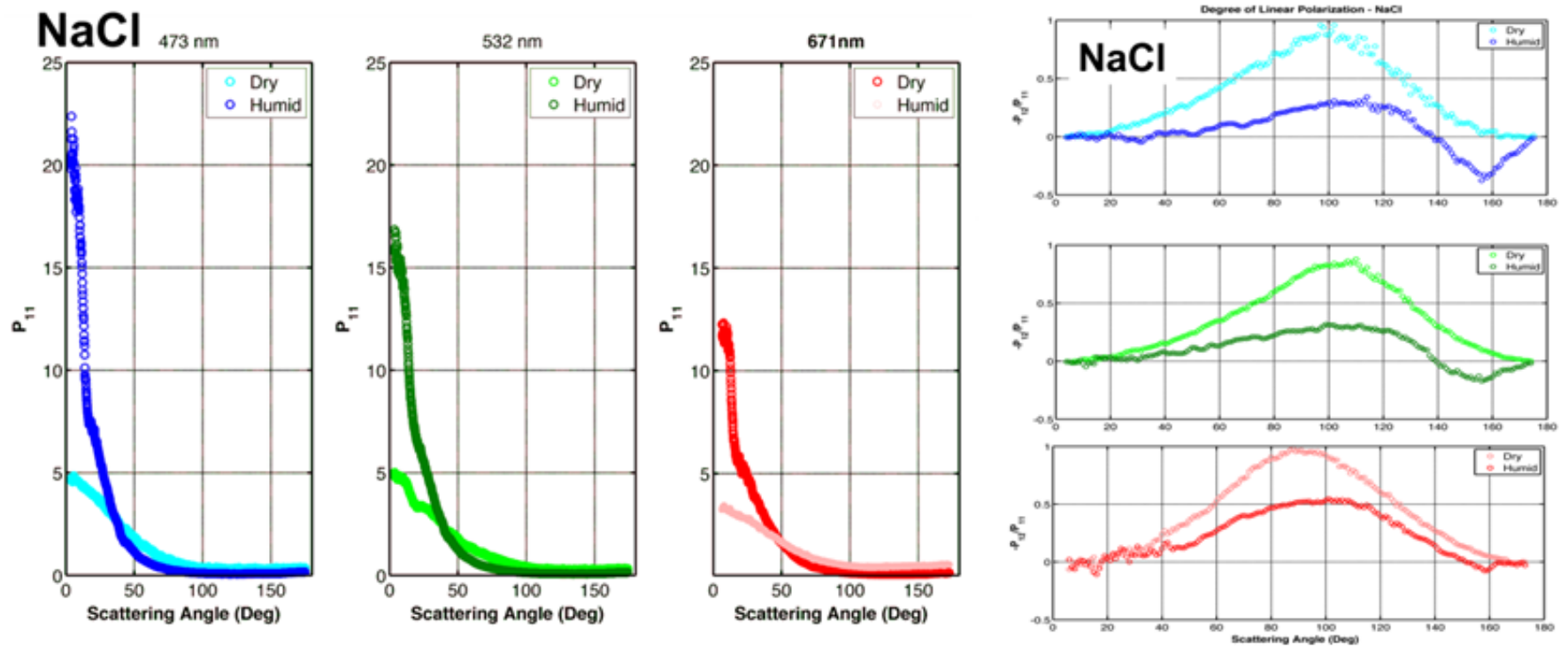
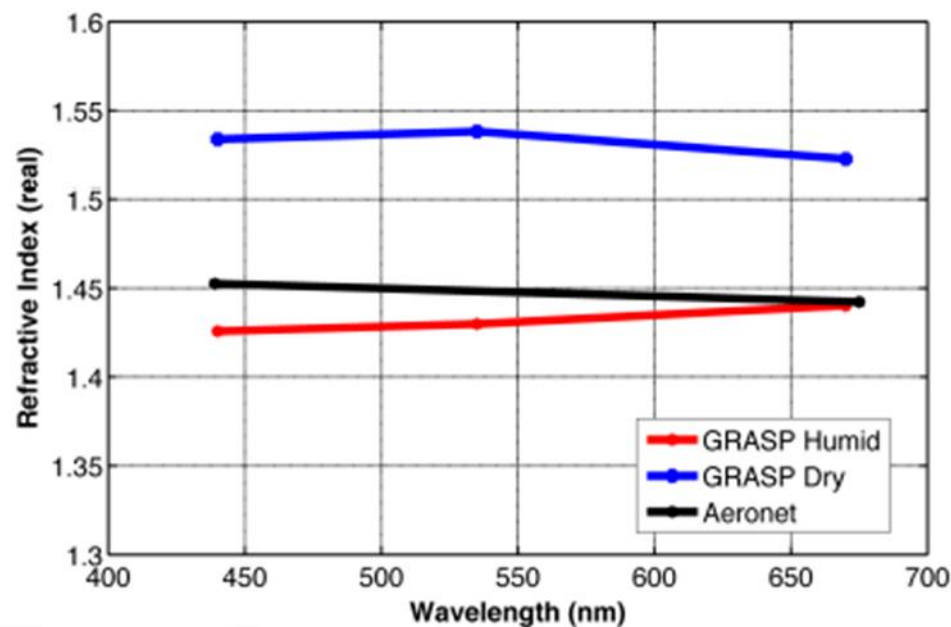


Figure 6 – Example of $PI-Neph$ measured dry versus humidified phase functions for laboratory generated NaCl aerosols. The three figures on the left-hand side show the evolution of P_{11} at three wavelengths (471, 532, and 671nm) for two different RH values (<20% and ~80%), and the three right-hand side figures shows the variation in P_{12} .

GRASP Inversion X theory for Humidified Refractive indices:

Compound	RH(%)	κ	n GRASP	n Theory
$NaCl$	83	0.91-1.12	1.380	1.347-1.352
$(NH_4)_2SO_4$	84	0.33-0.53	1.380	1.379-1.413
$(NH_4)NO_3$	82	0.33-0.53	1.375	1.361-1.380

Ambient Aerosols:



PI-Neph X AERONET size distributions

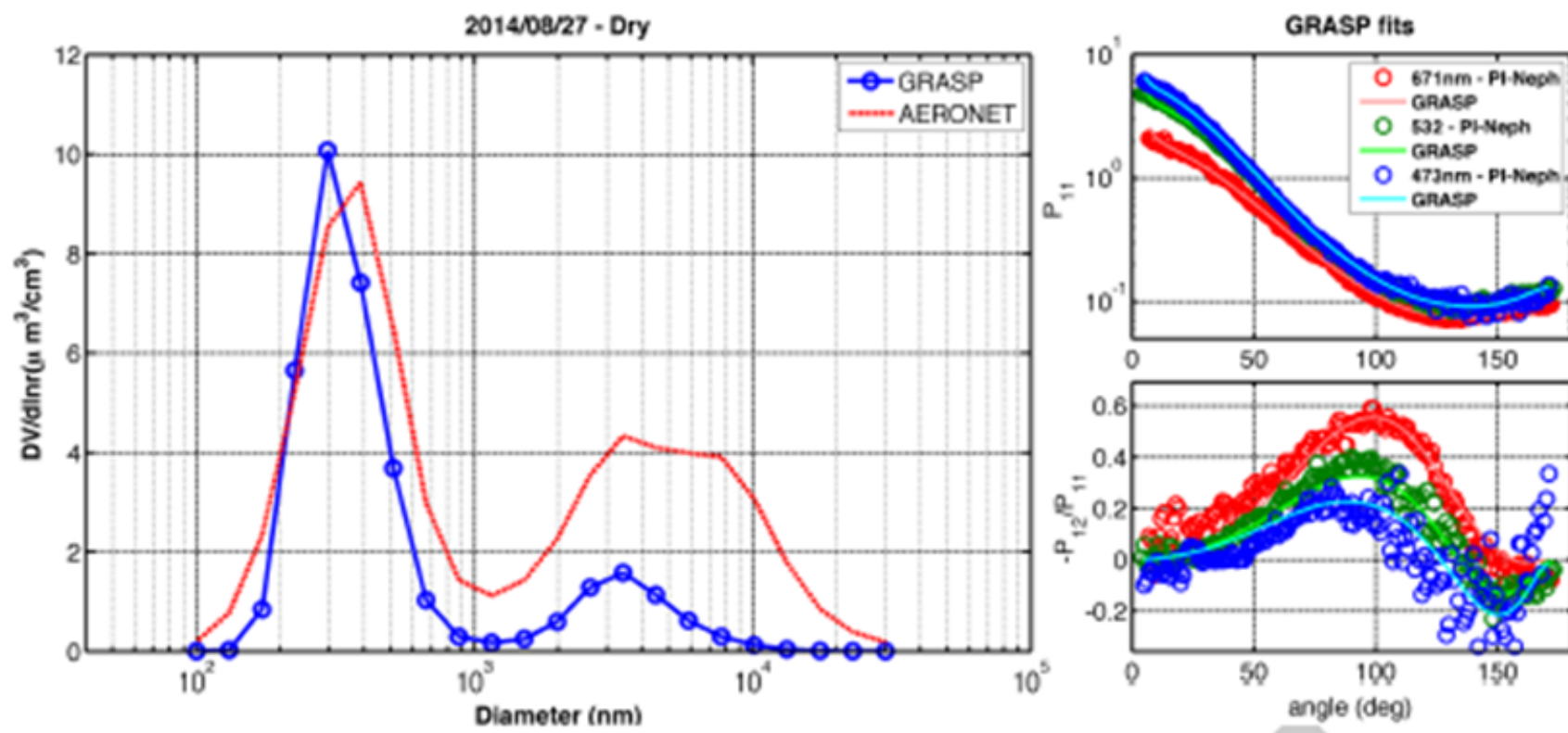
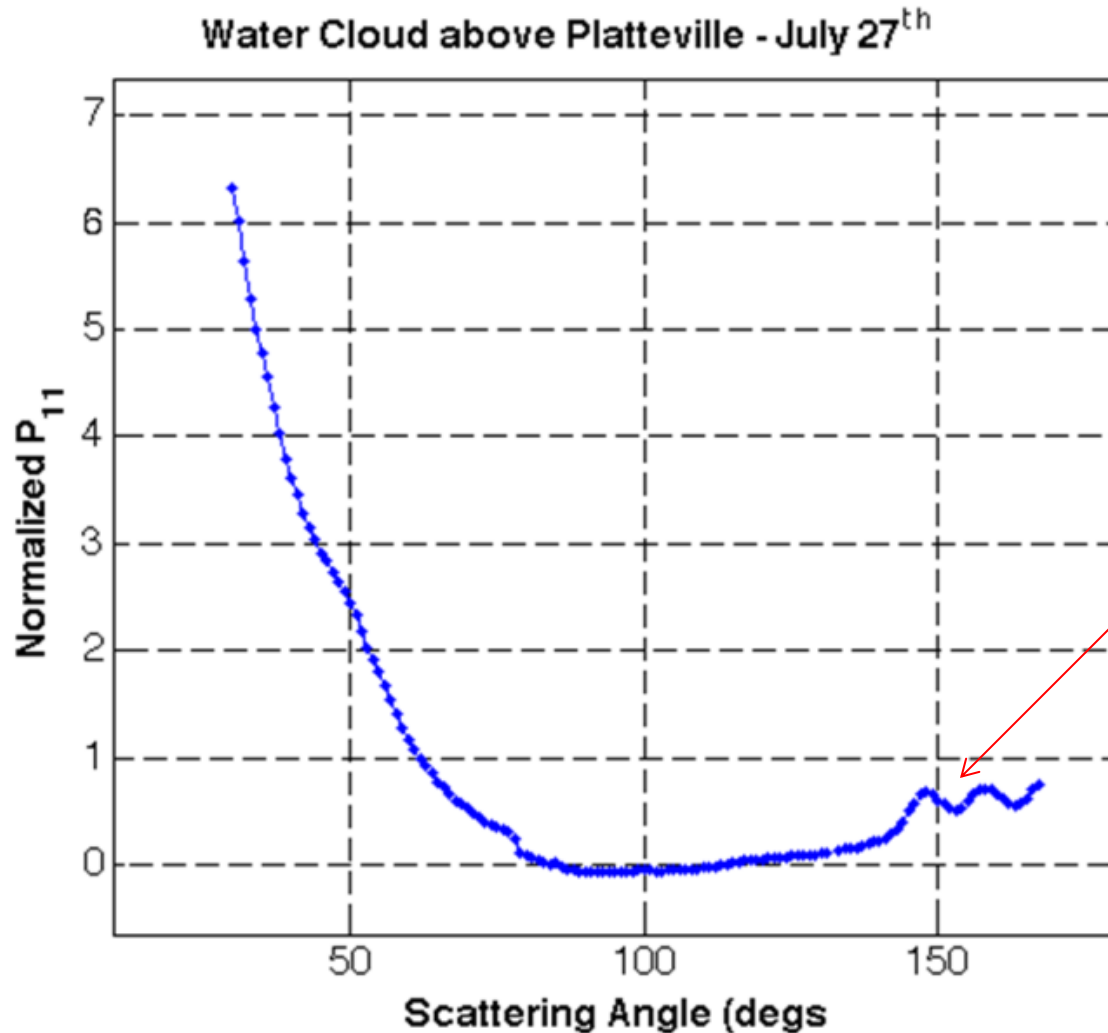
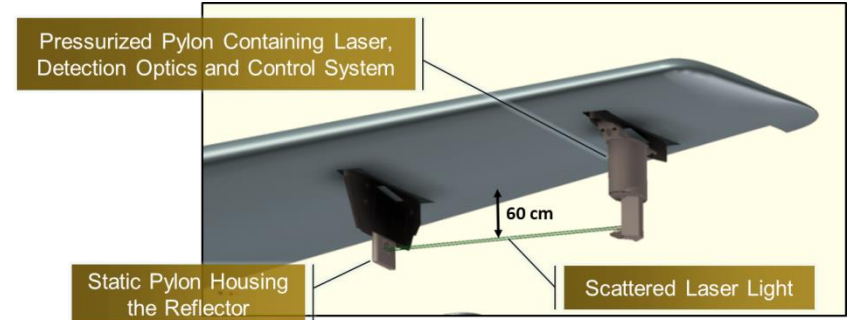


Figure 12 – Retrieval of the size distribution from the dried aerosols measured by the PI-Neph compared with the size distribution from AERONET. The AERONET results show clearly the stronger coarse mode than the PI-Neph which can derive from a few factors including: humidity and high humidification factor for these aerosols or particle losses in the inlet of the instrument and/or inside the diffusion drier,

In situ measurements of
Undisturbed particles:

**The Open Imaging
Nephelometer**

Open Ineph First Results from DAQ



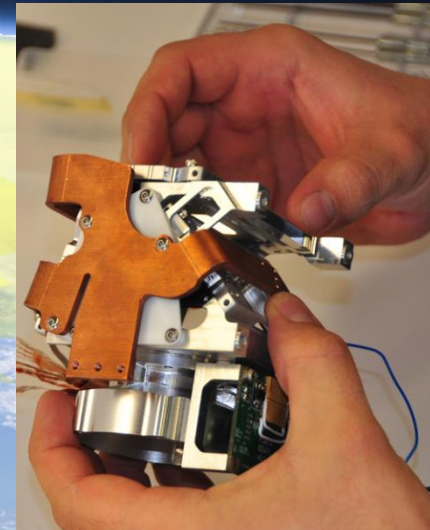
Measurement of
the cloudbow
inside the cloud

HARP Polarimeter Specs

- ISS orbit
- 60 angles for cloudbows
- 20 angles for aerosols
- 440, 550, 670, 870nm
- Nadir pixel resolution 600m
- Super pixel 2.5x2.5km
- 94 deg FOV X-track
- 117 deg FOV along track

HARP CubeSat Satellite to launch in Dec. 2016

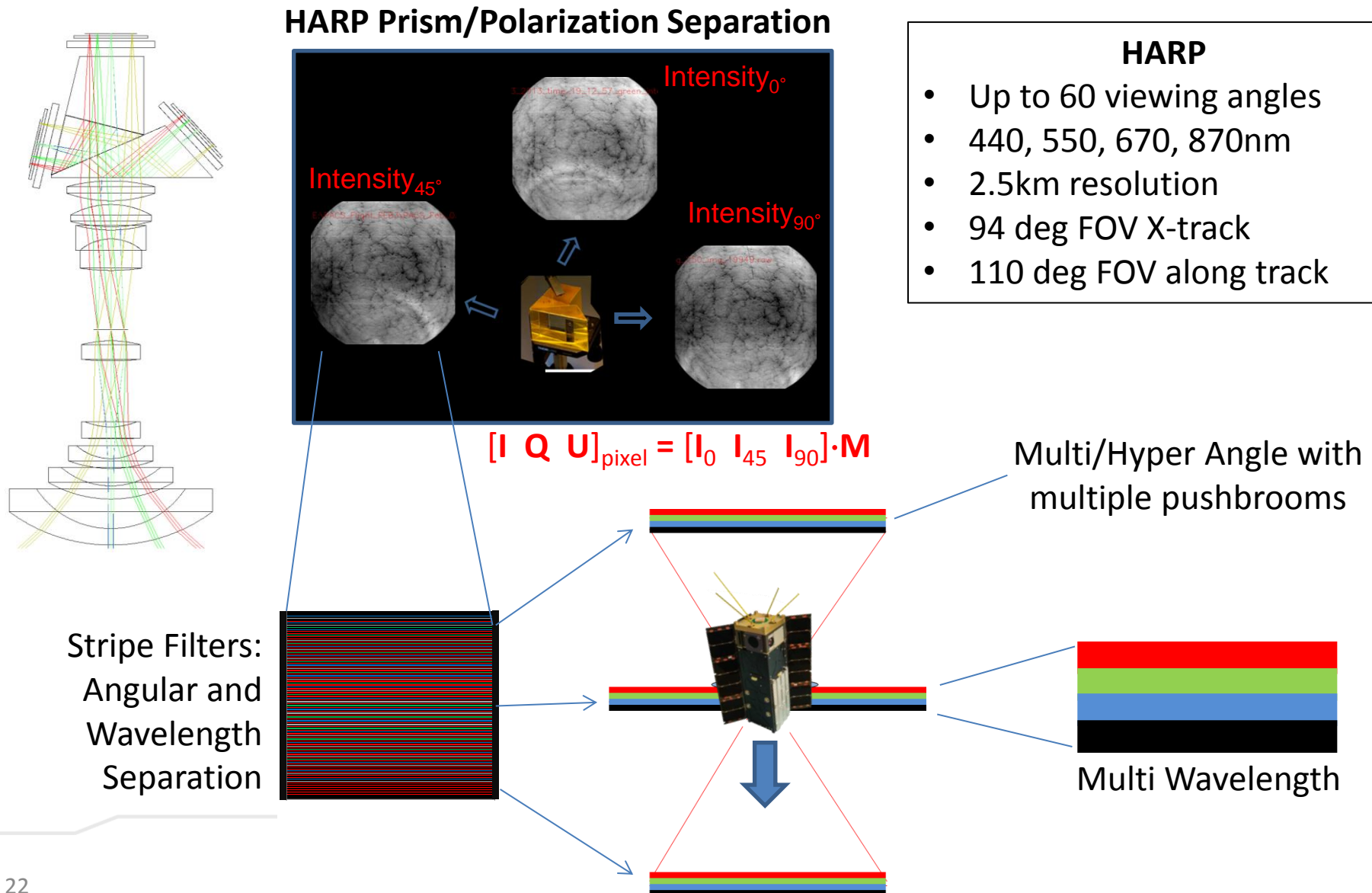
Repeat for all
along track
viewing angles



Imaging polarimeter

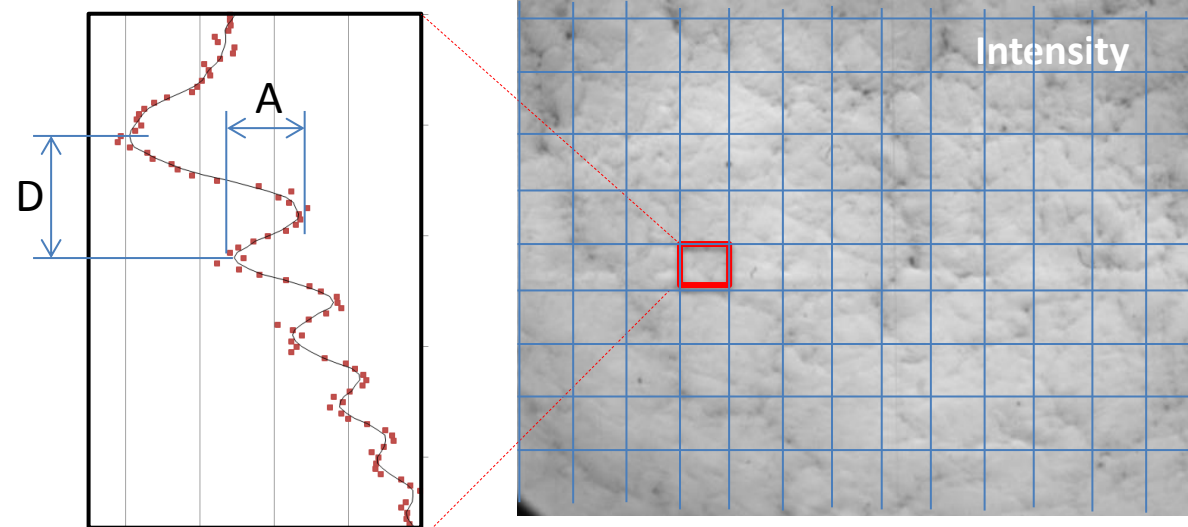


HARP Hyperangular Multi-Wavelength Polarization Images

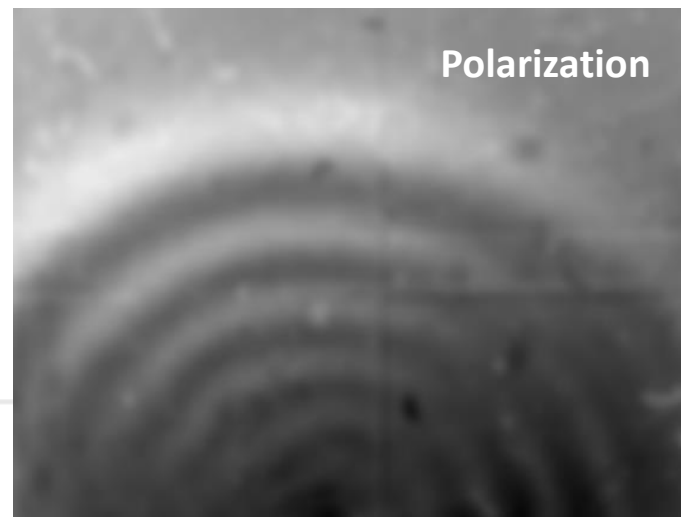


HARP CubeSat Polarimeter

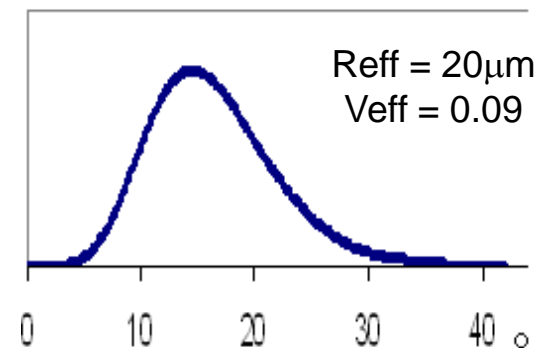
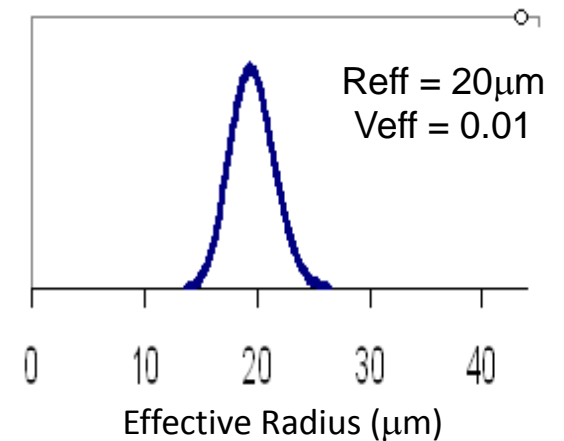
HARP Pioneering Hyper-Angular Capability will Provide Full
Cloudbow Retrievals from Small Area ($< 4 \times 4 \text{ km}$ from space)



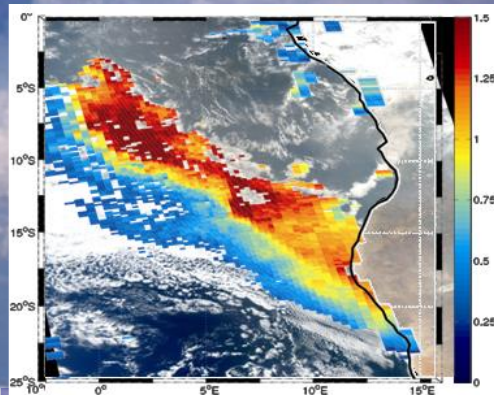
Same retrieval
capability for all
individual pixels with
 $< 4 \times 4 \text{ km}$ resolution



Water Droplet Distribution



These two cases are
undistinguishable from Intensity
measurements only (MODIS/VIIRS)

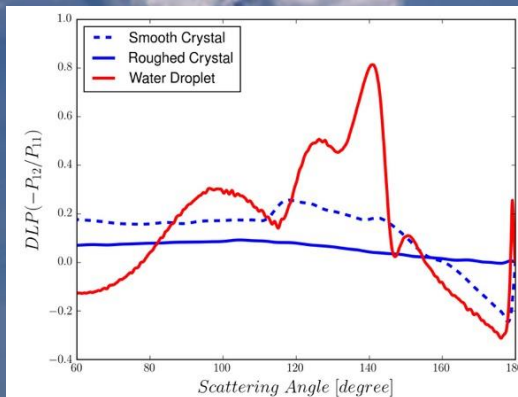


Aerosol above Clouds and Aerosol Absorption (UV and Polarization)

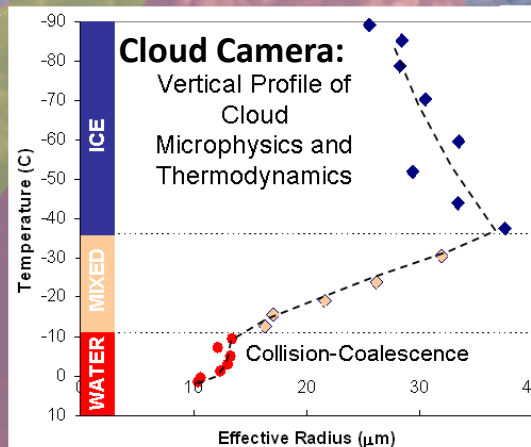
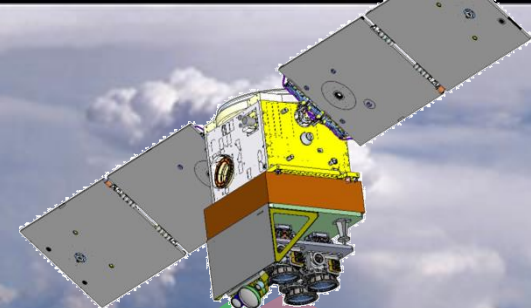


Cloudbow – Water Clouds

**Volcanic Ash,
Twilight Aerosols, etc.
(Polarim. + Cloud Radiometer)**



Ice/water particle's scattering



Cloud Camera:

Vertical Profile of
Cloud
Microphysics and
Thermodynamics

Collision-Coalescence

CLAIM-3D

PI: J. Vanderlei Martins (UMBC – JCET / 613)

Project Scientist: A. Marshak (GSFC 613)

- *The interaction between aerosol and clouds carry the largest uncertainty in climate forcing*
- *CLAIM-3D will determine how cloud evolution, droplet sizes, lifetime, vertical structure, thermodynamic phase, and ice particle structure vary as a function of aerosol type and amount*

- *CLAIM-3D has unprecedented combination of mature instruments and algorithms to address the interaction between aerosols and clouds*
- *CLAIM-3D is designed to provide a full court press characterization of the interactions between aerosol and clouds*

The ideas:

- **Aerosol Absorption**
- **Cloud Side Measurements**
- **Design of new satellite missions**

The reality today...

- Multiple critical reflectance papers
- Sunlint: aerosol absorption over water
- Spectral reflectance: aerosol microphysics, imaginary refractive indices, composition...
- First cloud scanner instrument was built and demonstrated in the Amazon
- 3D simulations: Marshak, Zinner, etc.
- Current measurements and proposals by several European organizations and Brazil
- ACE, CLAIM-3D
- HARP CubeSat satellite early 2017
- PACS in situ + Remote Sensing Suite
 - PACS Imaging Polari meter (HARP)
 - High resolution cloud measurements
 - Imaging Nephelometer measurements

Thank you Yoram



***...for the ideas, motivation,
support, friendship
and for the reality...***

